Anaerobic Digestion and the Renewable Energy Standard Offer Program

D. Hilborn, J. DeBruyn and S. Clarke

Factsheet

ORDER NO. 07-051 AGDEX 770 OCTOBER 2007
(replaces OMAFRA Factsheet Anaerobic Digestion and the Standard Offer Program, Order No. 07-017)

INTRODUCTION

In November 2006, a Renewable Energy Standard Offer Program (RESOP) was introduced by the Ontario provincial government to provide long-term prices for the sale of electrical power generated from renewable energy sources in Ontario. The RESOP will bring about a variety of new opportunities for energy generation in Ontario. One area of considerable interest to the agriculture and food sector will be the production of biogas from the anaerobic digestion (AD) of manure, energy crops and other agricultural or food-based materials. This Factsheet outlines some of the basics of the RESOP and gives information on biogas systems and their application in Ontario.

It is important to keep up to date as new developments unfold in the electricity sector. Consult the RESOP information prepared by the Ontario Power Authority for more details: www.powerauthority.on.ca/sop.

THE RENEWABLE ENERGY STANDARD OFFER PROGRAM

The Renewable Energy Standard Offer Program was developed to provide opportunities to integrate small- and medium-scale renewable energy projects into Ontario's electricity supply system. The details of the RESOP were developed by the Ontario Power Authority (OPA) in conjunction with other industry stakeholders, including the Ontario Energy Board (OEB) and the Ontario Ministry of Energy. The OPA undertook extensive consultations and developed the RESOP using the following guiding principles. The program should:

- be kept simple
- focus on removing barriers to smaller clean or renewable energy generation
- be built on the early efforts of the Ontario Sustainable Energy Association
- balance between the government's renewable energy generation targets and the value of the electricity to the ratepayer

RENEWABLE ENERGY OPPORTUNITIES IN AGRICULTURE

Renewable electrical generation generally includes power produced from wind, biomass, water and solar systems. Other renewable energy systems, such as ground-source heat pumps and solar walls, provide opportunities for energy savings, but these systems do not result in new electricity generation. For agricultural situations, wind, solar and biogas systems are considered to have the highest immediate potential for electrical power production with the broadest application around the province.

HOW DOES THE RENEWABLE ENERGY STANDARD OFFER PROGRAM WORK?

The Renewable Energy Standard Offer Program will give generators of electrical power meeting the criteria for renewable energy a price of 11¢/kWh for the electricity put on the Ontario grid. This price is available for wind, biomass (including biogas) and small hydro developments. Energy from solar photovoltaic (PV electric) technology will receive 42¢/kWh.

The electricity contract guarantees payments for a 20-year period. The prices for non-PV power will be increased at a rate of 20% of the consumer price index per year. Starting May 1, 2007, the non-PV rate was escalated to 11.04¢/kWh.

Because of the RESOP funding process, the OPA will claim benefits from certain environmental programs, which will mean they are not available or partially available to the alternative power generator. For example, all payments received under the federal ecoENERGY for

Ministry of Agriculture, Food and Rural Affairs

Ontario

Renewable Power program (formerly the Wind Power Production Incentive, or WPPI) will be shared equally between the OPA and the energy generator. The OPA will post details on its website listing programs that give payment directly to the energy generator.

There is no minimum production capacity to participate. The maximum project size is 10 MW.

PEAK POWER TIMES

There is an additional rate of 3.52¢/kWh for power produced during peak times. The peak power price boost will only be available to generators able to reliably generate during 80% of peak hours. Most biogas systems will achieve this requirement.

Peak power times occur between 11 AM and 7 PM, Monday to Friday, during regular working days, meaning roughly 2,000 available peak power hours per year.

Generation during off-peak hours will receive the base rate of 11¢/kWh (before the 20% adjustment to account for inflation is added). A standard, farm-based biogas system would operate a minimum of about 3,000 hours per year. If this operation always produces during the peak periods, the maximum blended rate paid will be about 13.4¢/kWh (before the 20% adjustment to account for inflation is added). If the generator runs almost continuously (8,000 hr/yr), the blended rate paid will be about 11.9¢/kWh (before any inflation factors are added).

Designing a system to operate only some of the time (e.g., during peak hours) adds additional costs due to:

- the increased size of generator system and associated line connection
- the cost of additional biogas storage
- the requirement to use engine or biogas treatment systems that function properly with daily shutdowns

RESOP TRANSMISSION CONSTRAINT ZONE

At the time of writing (August 2007), there is a restricted transmission constraint zone.

Figure 1 shows an area where there are functional limits on the transmission system. Although a particular property may be located within the constraint zone, it may receive its electricity service via a local utility feeder that connects to a transformer station outside the zone, and so be allowed under the RESOP. The reverse also holds: a property that is physically outside the zone may still be serviced by a utility feeder that connects to a restricted transformer station within the restricted zone, and so projects on that site would not be eligible for RESOP (except for micro and farm-based bioenergy projects listed below).

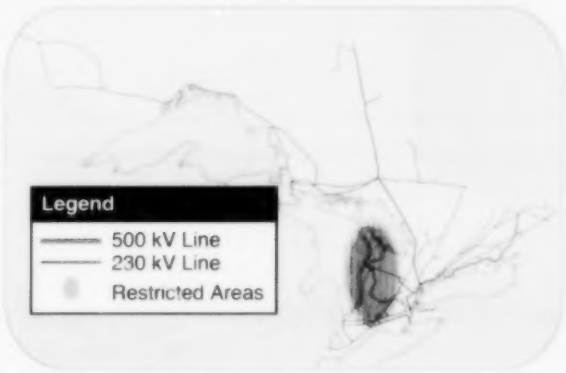

Figure 1. Location of transmission constraint zone in the Ontario electrical transmission system.

Within this zone, the OPA will only issue RESOP contracts to the following types of new projects:

- Micro projects that have a capacity of ≤10 kW
- Farm-based bio-energy projects that have a capacity of ≤250 kW

The aggregate capacity of all the RESOP projects in the zone cannot exceed 10,000 kW (10 MW).

A farm-based bio-energy project is defined in the RESOP as a project that forms part of an Ontario-situated farming business (as defined in the *Farm Registration and Farm Organization Funding Act*, 1993 (Ontario)) operated by the applicant or a person not at arm's length to the applicant, that generates electricity from renewable biomass, biogas or biofuel.

A 250-kW farm-based project running 8,000 hr per year would require manure from 3,000 head of beef feeder cattle if manure were the sole input. If energy crops were the sole input, approximately 125 ha of corn silage would be required to feed this size digester.

USAGE OF RENEWABLE POWER BY THE FARMSTEAD

At the time of writing, it is understood that if a generator were metered within the farmstead, the farmer would get paid the RESOP price for all the generated power and would pay the Hourly Ontario Energy Price (HOEP) for the power used within the same hour.

Thus, the farmer would not pay the transmission and distribution costs for the power used. This adds value for a farmstead that uses significant power at the same time it is generated. Siting a project in this way may result in additional metering and account expenses and should be discussed with the local utility. The effect of other factors, such as demand charges, will depend on the customer's specific situation.

BIOGAS FROM ANAEROBIC DIGESTION OF ORGANIC INPUTS: A QUICK EXPLANATION

At a livestock or crop farm, biogas will be produced from the anaerobic digestion (AD) of organic materials such as manure, agricultural residues, food-based organic materials and energy crops. As organic matter is broken down by anaerobic bacteria, biogas is produced.

Biogas primarily contains methane (50%–65%), carbon dioxide and water vapour. Natural gas contains over 99% methane, meaning biogas is essentially diluted natural gas. Biogas produces electricity when used as a fuel in an engine that drives a generator. Often in agricultural systems, a standard diesel or spark engine is modified to burn the biogas to turn a generator to produce electricity. Between 25% and 40% of the energy in the biogas is converted to electricity. The remaining available energy is converted to heat that is used to heat the materials in the anaerobic digester and for other purposes, such as heating a home, shop or greenhouse. Most biogas plants produce surplus heat. There is potential to improve the economics by using this heat to replace conventional heat sources.

Anaerobic digestion of manure produces an end product (called digestate) that in many cases has at least a 97% reduction in pathogen and odour levels. While there is little volume or nutrient reduction in anaerobic digestion systems, a higher percentage of the nutrients in the digestate are in an inorganic form, similar to conventional fertilizer. Typically, the digestate is land-applied in a manner similar to liquid manure for use with conventional field crops. Timing of application is critical, since the readily available nutrients could be lost if not quickly utilized by the crop.

Digestate can be passed through a solid separator system that produces a high-quality solid material. This material could be used in other settings such as horticultural applications. This may assist the nutrient management plan for the farm by moving nutrients (contained in the solid material) off the farm. In addition, this separated solid material works effectively as a livestock bedding material.

An effective biogas plant optimizes many biological and mechanical processes. Proper equipment and training are necessary to ensure good operation. Countries such as Austria, Denmark, Germany and Switzerland have excellent experience with these systems; however, consideration must be made to address differences in climate, rules and electrical processes when considering imported technologies.

More information on AD systems is available in the OMAFRA Factsheet 07-057, *Anaerobic Digestion Basics*.

MATERIALS TO BE MIXED IN AN ANAEROBIC DIGESTER

A digester requires volatile organic material to produce biogas. Historically, manure has been the primary source of material that is digested. Manure can be provided daily and contains material readily broken down by anaerobic bacteria. Farm-based materials, including straw (used in bedding), waste feed, grain cleanings and horticultural byproducts, can also be digested. In addition to farm-based materials, other food or plant-based materials can be digested successfully. Lab tests can determine the biogas production potential of different materials.

Note: A Certificate of Approval (C of A) may be required from the Ministry of the Environment (MOE) to accept off-farm source materials (contact your local MOE office: www.ene.gov.on.ca/envision/org/op.htm).

Recent changes to the *Nutrient Management Act* (NMA) and *Environmental Protection Act* (EPA) facilitate the management of certain off–farm source materials at farm-based digesters through new regulatory limits in the NMA and an exemption from requirements under the C of A. For more information on the new regulations, search for "O. Reg. 267/03" on the e-laws website: www.e-laws.gov.on.ca.

Energy crops such as corn silage can also be used in the digester. European numbers indicate that almost 16,000 kWh of electricity (plus equal heat) can be produced from corn silage produced from 1 ha (yield of 45 wet tonnes). Since there are additional costs related to growing and harvesting energy crops, conduct a detailed economic analysis to ensure the process is economically viable before building a biogas system.

Producers must ensure the material does not contain components that may inhibit the biological process or eventually cause the process to stop. For example, antibiotics or high levels of nitrogen in the material may inhibit the biological process. Sand in the material will also affect the capacity of the digester when it settles to the bottom; it may also be difficult to remove.

ECONOMIC VIABILITY OF BIOGAS SYSTEMS

Many factors affect the viability of a farm-based or food processing–based AD system. These factors include the system's capital and operating costs, the value of the Renewable Energy Standard Offer Program and the rate of efficiency with which the system converts biogas to a usable form such as electricity. Due to the many factors, complete a detailed economic assessment before building an AD system. Funding programs may be available to help undertake this assessment (see the OMAFRA Infosheet *Considerations and Opportunities for Building a Farm-Based Anaerobic Digester System in Ontario*).

CONNECTING TO THE GRID

If you are considering implementing a biogas system at your farm, consider the following:

- Is 3-phase power available? Three-phase power may allow for greater power input into the grid (talk to your local power distribution company).
- Are there initial and/or ongoing costs associated with having a connection? For example, special switches may be required on the line to protect the generator and/or other users.
- Would the project connect to a utility feeder that in turn connects to a transformer station within the transmission-constrained area? If so, even if there is enough feeder capacity on the local grid, your project may still not be eligible for a RESOP contract (for more information, please see the earlier section, *RESOP Transmission Constraint Zone*).
- Is grid capacity available to accept power? Grid capacity could be limited by a number of components, such as the electrical feeder or the transformer station. An assessment of grid capacity must be completed by the power company.
- How long will it take to have a connection approved?

CONCLUSIONS

Biogas systems involve several components that must be properly operated and managed to achieve an economically viable system. These systems hold significant potential for pathogen reduction, odour control and better nutrient management. In addition, under the right circumstances, digesters will result in new economic opportunities for farmers and rural communities.

The Renewable Energy Standard Offer Program will provide some incentive to farmers and others to consider when developing biogas systems.

OTHER RESOURCES

The Ontario Power Authority's RESOP website provides program details for the RESOP (www.powerauthority.on.ca/sop).

OMAFRA's website, particularly the energy links found under the Engineering section, provides useful information, including OMAFRA Factsheets, an anaerobic digestion video, links to conference proceedings and links to other energy resources.

This Factsheet was co-authored by Don Hilborn, P.Eng., Engineer, Byproducts Management, OMAFRA, Woodstock; Jake DeBruyn, P.Eng., Engineer, New Technology Integration, OMAFRA, Guelph; and Steve Clarke, P.Eng., Engineer, Energy and Crops, OMAFRA, Kemptville. This Factsheet was reviewed by Elin Gwyn, MSc, Marketing and Communications Officer, OMAFRA, Guelph, and Kevin Devitt, Senior Analyst, Electricity Resources, Ontario Power Authority.

Agricultural Information Contact Centre:
1-877-424-1300
E-mail: ag.info.omafra@ontario.ca
Northern Ontario Regional Office:
1-800-461-6132

www.ontario.ca/omafra

POD
ISSN 1198-712X
Également disponible en français
(Commande n° 07-052)